Trochammina semi-specific assemblages from the Upper Paleocene of the Silesian Nappe, Polish Outer Carpathians

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Abstract

Foraminiferal assemblages rich in *Trochammina* are described from the uppermost part of the Istebna Beds within the Silesian Nappe (Polish Outer Carpathians). The percentage of *Trochammina* is 55% and 35% of all foraminifera, making this genus numerous in assemblages. Semi-specific *Trochammina* assemblages, dominated by the epifaunal eco-group, are represented by dwarf, thin-walled specimens of cosmopolitan taxa, suggesting they developed in a crisis condition. The late Paleocene age of these assemblages is established based on stratigraphic ranges co-occurring agglutinated and planktonic foraminifera, and on superposition of the host rocks.

INTRODUCTION

In the Outer Carpathians, the Paleocene deposits are dominated by turbiditic (so-called flysch) sedimentation. Thick-bedded sandstone complexes interbedded with sandy-shaley intervals are common. Such type of sedimentation resulted in the development of mostly agglutinated foraminiferal assemblages. The variability of these agglutinated assemblages is low, what is seen in biostratigraphic schemes dedicated to the Outer Carpathians (e.g., Geroch & Nowak, 1984; Olszewska, 1997) with only one zone – Rzehakina fissistomata – defining the whole of the Paleocene lasting 9.8 Ma.

During the Late Cretaceous, Paleocene, and Early or Early–Middle Eocene in the Silesian Basin a stage with the predominance of thick-bedded sandstone and conglomerate sedimentation took place (Książkiewicz, 1962; Golonka *et al.,* 2006). This stage is especially well represented in the Istebna and Ciężkowice beds. Occasionally the sedimentation rate changed and thick-bedded sandstone deposits were substituted by shaley-sandstone or shale intervals. In the Upper Paleocene such a complex, developed as shale with intercalations of thin-bedded sandstones, make up the sediments of the Istebna Beds. This unit is called the Upper Istebna shales (a lithostratigraphic subdivision in the range of a member), which overlie the Upper Istebna sandstones and underlie the Ciężkowice sandstones. These Upper Istebna shales were sampled and are the subject of micropalaeontological studies. The foraminifera obtained here have a character of *Trochammina* semi-specific assemblages, which is unique to the Paleocene (Waśkowska *et al*., 2016).

The foraminiferal assemblages discussed here were first mentioned in a geotourist paper by Cieszkowski *et al*. (2010) concerning the geological attractions of Melsztyn Hill with the ruins of the medieval Melsztyn castle. The present paper contains wider *stricte* micropalaeontological characteristics of the foraminiferal assemblages obtained from the Upper Istebna shales cropping out in the lower part of the Melszyn Hill slope. This study provides additional data about the palaeontological record of the upper Paleocene in the Polish Outer Carpathians.

Geological outline

The study area is located in the Outer Carpathians in Poland, on the territory of the central part of the Silesian Nappe (Książkiewicz, 1977; Golonka *et al*., 2006, Golonka & Waśkowska-Oliwa, 2007) (Fig. 1). This nappe contains mostly the rocks deposited in the Silesian Basin *sensu lato*, which were developed in the western part of the Tethys Ocean in the Outer Carpathian domain. The Silesian Basin was filled with flysch from the Late Cretaceous up to the Early Miocene even though a few stages of basinal evolution changed its tectonic structure and conditions of deposition (Cieszkowski *et al*., 2009, 2012). The different types of

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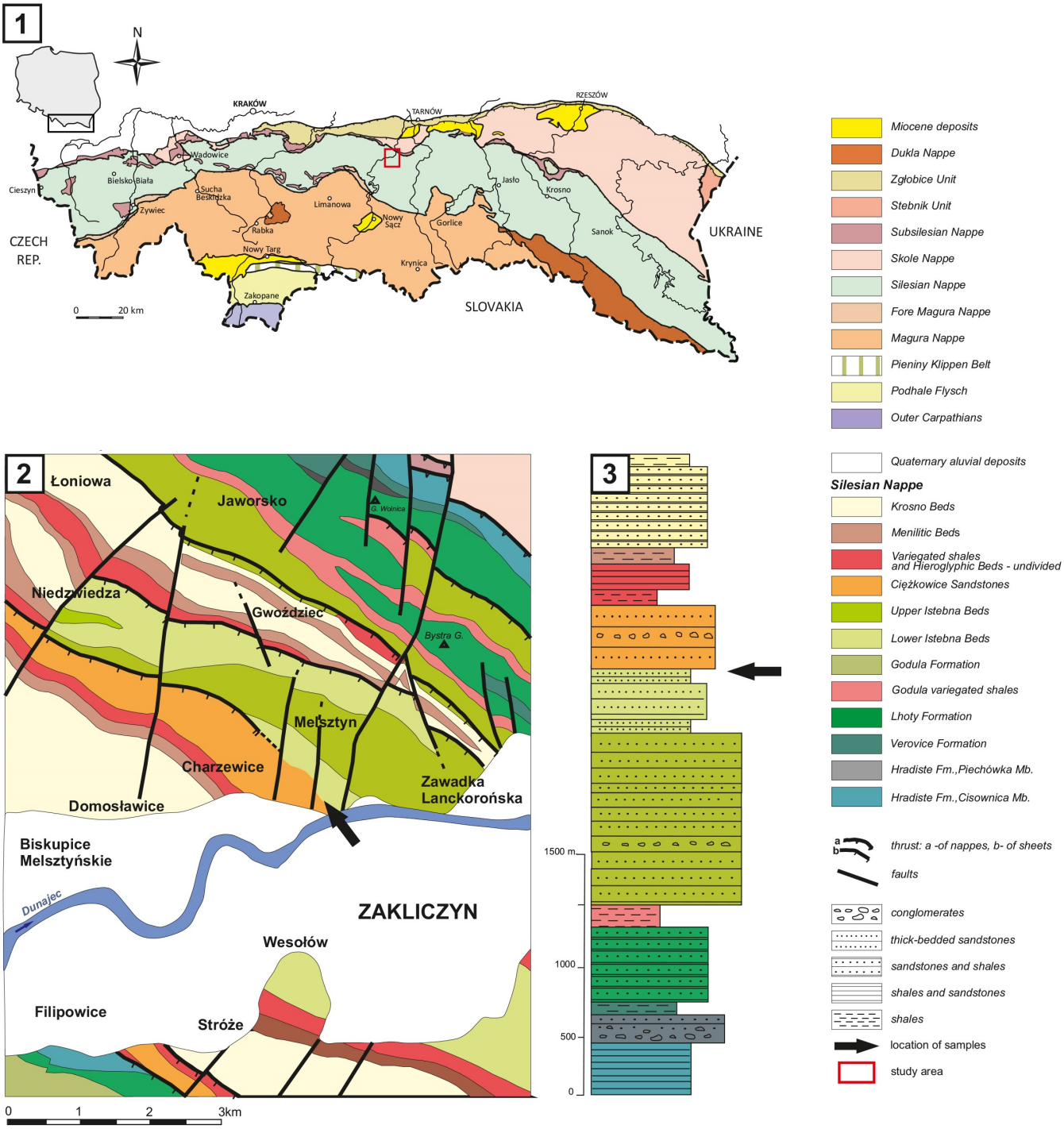

Figure 1. Location of sampled section: (1) on geological sketch map of the Polish Carpathians (map after Oszczypko, 1998, modified) and (2) on the geological map of the Melsztyn area (after Cieszkowski *et al*., 2010): (3) Position of sampled section against the lithostratigraphic log of the Silesian Nappe (after Cieszkowski *et al*., 2010).

clastic deposits are mainly an effect of turbidite sedimentation filling this area. During the Alpine orogenic movements these deposits were folded, uprooted from their basement, and uplifted. Then the Silesian Nappe was pushed tectonically to the north and overthrust onto the Subsilesian and Skole nappes as well as the Miocene deposits infilling the Carpathian Foredeep that transgressively onlap the North European Platform (Książkiewicz, 1976; Golonka *et al*., 2006).

The sampled deposits which represent the Upper Istebna Beds (Upper Istebna Shales) crop out on the slope of the Melsztyn Castle Hill, located in the Rożnów Foothills on the left bank of the Dunajec River in Melsztyn village (Fig.

Figure 2. Sampled outcrop of the Upper Istebna Beds.

1). They occur there within the Jurków-Zakliczynczyn and Gwoździec thrust sheets *sensu* Cieszkowski *et al*. (2010). These deposits belong to the Istebna Beds, which form one of the thickest lithostratigraphic divisions of the Silesian Nappe, consisting of two complexes of thick- and very thick -bedded sandstones and conglomerates (Fig. 1). In the study area the thickness of the Lower Istebna sandstones is more than 1000 m and the Upper Istebna sandstones is about 250 m. Thin-bedded shaley-sandstone deposits with significant domination of the shales separate the Lower and Upper Istebna sandstones and some similar Upper Istebna shales overlie the Upper Istebna sandstones and from the top are covered in the section by the Ciężkowice sandstones. Such a section is observed in the study area (Burtan *et al*., 1981; Cieszkowski *et al*., 2010), though Koszarski & Kuciński (1966) and researchers who followed them (Leszczyński *et al*., 2005, 2012) classified the Ciężkowice Sandstones occurring there as a member of the Upper Istebna Beds. The presented geological image of the Silesian Nappe in Melsztyn and surrounding area follows Cieszkowski *et al*. (2010) and was established on the basis of detailed geological mapping carried out in 2009.

The samples were taken from the uppermost part of the Upper Istebna shales, close to the first thick-bedded sandy layer rich in rhodoids (Melsztyn sandstones subdivision *sensu* Cieszkowski *et al*., 2010) (Fig. 1), which belong to the Ciężkowice sandstones. The sampled deposits are represented mostly by muddy gray and gray-beige muddy shales with rare intercalations of very thin-bedded and thin-bedded, sporadically medium-bedded, gray quartzite fine-grained sandstones (Fig. 2). At present the studied outcrop is not accessible.

METHODOLOGY AND MATERIAL

Two samples, MELSZTYN 1/09 and MELSZTYN 2/09, were analysed. The samples were collected by Marek Cieszkowski in 2009 from shaley deposits outcropping on the southern slope of the Melsztyn Castel Hill in Melsztyn Village (Fig. 1). The sampled deposits were represented by gray muddy shales. Approximately 0.5 kg of rock was prepared using a standard micropalaeontological method – first macerated in saturated Glauber's salt solution, and next washed over a 63 μm sieve. All microfossils from the resi-

dues were picked into slides.

Micropalaeontological material contains the tests of agglutinated foraminifera 340 and 380 specimens per sample. The accessory components were: one specimen of a planktonic foraminifera test and three radiolarian steinkerns. Within this material 21 genera were recognised. The state of foraminiferal test preservation was various, generally not good, a portion of the fossils have poorly visible details of test morphology. The tubular forms and other long tests are usually broken. Most of the foraminifera are represented by dwarf specimens and thin-walled, transparent tests. In some cases test surfaces were partly covered by limonitic crusts. In sample MELSZTYN 2 the part of foraminiferal tests (only large specimens), belonging to the Spiroplectamminacea, Recurvoidacea, Astrorhizacea, and Saccamminacea, are red coloured or infilled with red clay sediment.

The foraminifera were analysed and photographed (Plates 1, 2) under a Nikon VL100POL binocular microscope in the Department of General Geology and Geotourism of WGiOŚ AGH. The samples are housed in the Micropress Europe Foundation at the AGH University of Science and Technology in Kraków.

RESULTS

Taxonomic composition

In total, 32 species which belong to 21 genera were recognised. The dominance of Trochamminidae, which constitutes 35% and 55% of all foraminifera, is the characteristic feature (Fig. 3). The tubular forms of Astrorhizida are the next numerous group of foraminifera. They are preserved as fragments of tubes, and their number does not reflect the real number of specimens. The amount of Astrorhizida fragments is 39% and 28%. In fact, they represent at least several smaller groups of foraminifera. It needs to be highlighted that taking into account this fact, the real number of other groups in studied material is higher. Figure 3 presents the distribution of the taxonomic diversity for comparison with and without taking into account the Astrorhizida. The rest of the assemblages belongs to the Ammodiscidae, Recurvoidacea, Lituolacea, Lituotubacea, Spiroplectamminacea, Rzehakinacea, Prolixoplectidae, Hormosinellacea, and Saccamminacea among which the Recurvoidacea constitutes a rich (6-7%) group, and in one of the studied samples the Spiroplectamminacea comprises 13% of all foraminifera (Fig. 3).

Semi-specific Trochammina assemblages

The dominant genus is small-sized *Trochammina* (Fig. 3). Such a high proportion of one taxonomic group permits this assemblage to be regarded as semi-specific. *Trochammina* is represented mostly by compressed specimens, difficult to recognise, and not assigned to the species level. It seems that *Trochammina* is represented by at least by two species. The most numerous specimens are close to the dwarf *Trochammina globigeriniformis* (Parker & Jones), but there are specimens close to the *Trochammina (Trochamminopsis) altiformis* (Cushman & Renz). Most of the foraminiferal specimens are represented by dwarf, thin-walled and transparent foraminiferal tests which indicates the Liliputian effect. Similar, small-sized *Trochammina* assemblages were described from the Lower Eocene of the Silesian Basin, where the number of *Trochammina* specimens reaches up to 80% (Waśkowska, 2012, 2015a, b). They occur in the lowermost part of the Hieroglyphic Beds, deposited higher within lithostratigraphic column of the Silesian Nappe - above the Istebna Formation and Ciężkowice Sandstone. In other Carpathian lithostratigraphic divisions, *Trochammina* is accessory group of foraminifera (Waśkowska, 2015b).

Spiroplectammina navarroana Cushman in *Trochammina* semi-specific assemblages

In the sample MELSZTYN 2/09 the Spiroplectamminacea is represented only by one taxon - *Spiroplectammina navarroana* Cushman. Most specimens are broken, without the oldest-most fragile part of the test. They are red coloured and with red clay sediment infilling the chambers (Pl. 2). This suggests the first place of deposition within red shales, not within the gray muddy shales of the Upper Istebna Shales. In similar state of preservation is part of the specimens of *Placentammina placenta* (Grzybowski), *Recurvoides,* and *Bathysiphon* sp. All these tests belong to the large specimens in the studied samples and constitute the redeposited material. Despite of this, the rich occurrence of *Spiroplectammina navarroana* in the Carpathian deposits is interesting. It was observed in the Carpathian Paleogene of the Rożnów Lake Olistostrome (Waśkowska & Cieszkowski, 2013, 2014). *Spiroplectammina navarroana* occurred in the olistolithic clasts and in the olistostrome matrix, so represented also redeposited material. Usually, in the Outer Carpathians *Spiroplectammina navarroana* is relatively common, but it is an accessory component of foraminiferal assemblages. This taxon is a ubiquitous component of flysch-type assemblages, recognsed in many sections around the world (Kaminski & Gradstein, 2005 and references therein). It is numerous in the Late Palaeocene–Early Eocene of Boreal seas (e.g. Gradstein & Kaminski, 1989; Kinsey, 2000; Nagy *et al.*, 2004).

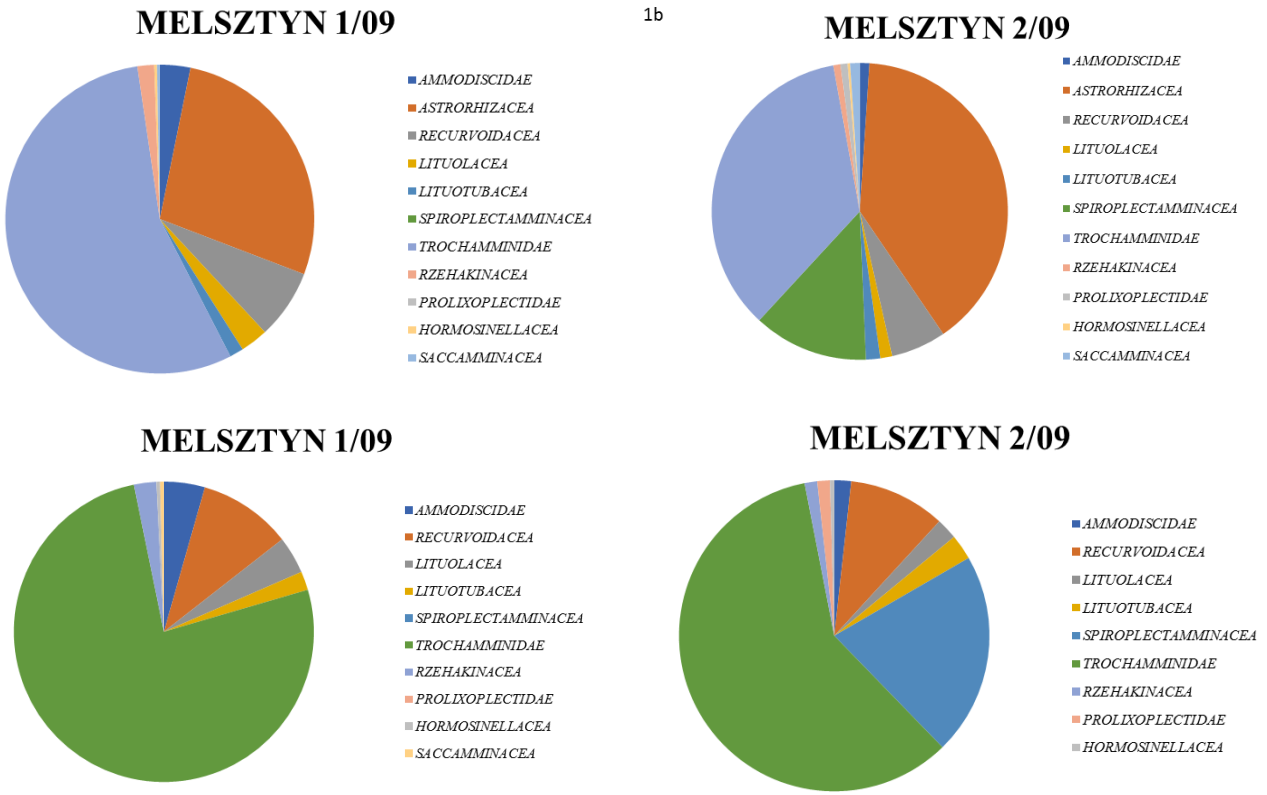

Figure 3. 1 – Full taxonomic distribution of foraminiferal assemblages, 2 - Taxonomic distribution of foraminiferal assemblages without tubular forms.

Biostratigraphy

The foraminiferal assemblages are dominated by long-ranging and cosmopolitan forms typical for Cretaceous – Paleogene time with only single forms possessing biostratigraphical value. One of the most significant is the *Rzehakina* group. It is relatively rich (1–3% of all foraminifera in the sample) in the studied material. The genus is represented by four species: *Rzehakina epigona* (Rzehak), *Rzehakina minima* Cushman & Renz and *Rzehakina lata* Cushman & Jarvis which lived in latest Cretaceous and Paleocene time, and *Rzehakina fissistomata* (Grzybowski), which is limited only to the Paleocene (e.g., Jurkiewicz, 1967; Jednorowska, 1975; Olszewska *et al*., 1996; Olszewska, 1997; Kaminski & Gradstein, 2005 and references therein). The latter species is the marker and index taxon for the Outer Carpathian foraminiferal Paleocene biozone (e.g., Geroch & Nowak, 1984; Olszewska, 1997; Kaminski & Gradstein, 2005; Waśkowska-Oliwa, 2008 and references therein). Moreover, in the studied assemblages single specimens of other Senonian – Paleocene species were found, such as *Glommospira* cf. *diffundens* Cushman & Renz, *Caudammina ovuloides?* (Grzybowski), *Haplophragmoides suborbicularis* (Grzybowski), and *Haplophragmoides stomatus* (Grzybowski). This group of species is more common and numerous in the Upper Senonian – Lower Paleocene Carpathian deposits, in the Thanetian their number and diversity gradually decrease (Waśkowska-Oliwa, 2008). Most of them disappear above the Paleocene/Eocene boundary. Poorly preserved specimens of *Subbotina* were found among the agglutinated foraminifera. The species is closer to *Subbotina velascoensis* (Cushman), than to *Subbotina linaperta* (Finlay), which was first suggested by Cieszkowski *et al*. (2010). The species *Subbotina velasocoensis* was noted from the upper Paleocene up to the Lower Eocene (e.g., Olszewska *et al*., 1996; Olsson *et al*., 1999; Premoli-Silva *et al*., 2003; Pearson *et al*., 2006, and references therein) or up to the end of Paleocene (Jednorowska, 1975). Taking into account the above data, the studied *Trochammina*-rich assemblages correspond to a Thanetian age. This age is consistent taking into account the superposition of the uppermost part of the Istebna shales.

DISCUSSION

The *Trochammina* acme is a widespread event in the Silesian Basin occurring in Ypresian time (Waśkowska, 2015a, b). It is after the Paleocene-Eocene Thermal Maximum (PETM). In the Paleogene sections it is found above the *Glomospira* acme or partly replacing the *Glomospira* as-

semblages, but above the last occurrence of *Rzehakina fissistomata* (Waśkowska, 2015a). In the studied assemblages, numerous *Trochammina* sepcimens co-occur with Paleocene *Rzehakina fissistomata* and other species that disappear after the PETM crisis. The Paleocene and Ypresian *Trochammina* assemblages display some similarity, however is difficult to indicate their interrelationship. However, domination of one taxonomical type, domination of the epifaunal eco-group and the Lilliputian effect indicate the features of crisis assemblages. It is possible that the development of such type of assemblages was connected environmental changes that took place during the PETM.

A separate issue is raised by the presence of numerous *Spiroplectammina navarroana*. They are redeposited, however the phenomenon of *Spiroplectammina navarroana*- rich assemblages is poorly known in other Carpathian sedimentary environments. *Spiroplectammina navarroana* is known from Upper Cretaceous – Lower Paleogene deposits of the Carpathians, where it is rather rare (e.g., Geroch, 1960; Morgiel & Szymakowska, 1978; Cieszkowski, 1992; Waśkowska-Oliwa, 2005, 2008). In the Silesian Nappe *Spiroplectammina navarroana*-rich assemblages were found in a large olistrostrome in the Rożnów Lake area (Cieszkowski & Waśkowska, 2013; Waśkowska & Cieszkowski, 2014). The Melsztyn area is the second known locality in the Polish Carpathians where numerous redeposited *Spiroplectammina navarroana* can be found. This finding documents the development of assemblages rich in this taxon within the Silesian Basin, which took place in the shallower basinal parts above the sedimentary area of the studied Upper Istebna Shales.

CONCLUSIONS

In the uppermost part of the Istebna Beds in the Silesian Nappe (Melsztyn area, Rożnów Foothills) the *Trochammina* semi-specific assemblages were recognised. The number of *Trochammina* is 35% and 55. The small sizes of agglutinated foraminifera tests indicate the Lilliputian effect.

The late Paleocene age of this assemblages was determined based on the presence of the Paleocene *Rzehakina fissistomata* (Grzybowski) with the co-occurrence other biostratigraphical marker species such as *Glommospira* cf. *diffundens* Cushman & Renz, *Caudammina ovuloides?* (Grzybowski), *Haplophragmoides suborbicularis* (Grzybowski), *Haplophragmoides stomatus* (Grzybowski), other species of *Rzehakina,* and poorly preserved *Subbotina velascoensis*?.

The upper Paleocene *Trochammina* semi-specific assemblages have a similar structure to the Ypresian *Trochammina* acme assemblages from the Silesian Basin, but at present it is difficult to indicate their relationship.

The numerous specimens of *Spiroplectammina navarroana* Cushman in one of the samples is caused by redeposition. Redeposited foraminifera indicate the development of unknown *Spiroplectammina navarroana* - rich assemblages in the shallower parts of the Silesian Basin.

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SYSTEMATICS

The taxonomic documentation of all identified species from the uppermost Istebna Beds in the Melsztyn section is listed alphabetically.

***Ammodiscus* cf. *peruvianus* Berry, 1928**

Ammodiscus peruvianus Berry, 1928, p. 342, pl. 27.

***Ammosphaeroidina pseudopauciloculata* (Mjatliuk, 1966)**
Plate 1, Figs 15, 16

Cystamminella pseudopauciloculata Mjatliuk, 1966, p. 264, pl. 1, figs 5-8, pl. 2, fig. 6, pl. 3, fig. 3.

Ammosphaeroidina pseudopauciliculata (Mjatliuk). – Bubik, 1995, p. 79, pl. 12, fig. 9.

***Annectina* sp. 1**
Plate 1, Figs 7-9

Description. Test free, circular or slightly elliptical in outline. The initial part of the tubular chamber (2 whorls) is miliolid-like coiled, followed part (4 whorls) is coiled planispirally. Diameter of tube increasing slowly. Aperture at the end of the tube. Test small, 200–300µm in diameter, thin-walled, transparent, finely agglutinated. Nine specimens in the studied material.

***Bathysiphon microrhaphidus* Samuel, 1977**
Plate 1, Fig. 3

Bathysiphon microrhaphidus Samuel, 1977, p. 19, pl. 11, figs 3-6, pl. 12, figs 1-4.

***Caudammina* aff. *ovuloides* (Grzybowski, 1901)**
Plate 1, Fig. 10

Reophax ovuloides Grzybowski, 1901, p. 268, pl. 7, fig. 3.
Hormosina ovuloides (Grzybowski). – Kaminski *et al*., 1988, p. 186, pl. 2, fig. 3-4.
Caudammina ovuloides (Grzybowski). – Kaminski & Gradstein, 2005, p. 238, pl. 42.

***Cribrostomoides* cf. *subglobosus* (Cushman, 1910)**
Plate 2, Fig. 8
Haplophragmoides subglobosum (Sars). – Cushman, 1910, p. 105, figs 162-164.
Cribrostomoides subglobosus (Cushman). – Kaminski & Gradstein, 2005, p. 391, pl. 92.

***Glomospira gordialis* (Jones & Parker, 1860)**

Trochammina squamata Jones & Parker, 1860, p. 304.
Glomospira gordialis (Jones & Parker). – Geroch, 1960, p. 46, pl. 4, figs 2, 5, pl. 10, fig. 5.

***Glomospira* aff. *diffundens* Cushman & Renz, 1948**

Glomospira diffundens Cushman & Renz, 1948, p. 15, pl. 1, fig. 30.

***Haplophragmoides excavatus* Cushman & Waters, 1927**
Plate 2, Fig 1
Haplophragmoides excavatus Cushman & Waters, 1927, p. 82, pl. 10, fig. 3.

***Haplophragmoides kirki* Wickenden, 1932**
Haplophragmoides kirki Wickenden, 1932, p. 85, pl. 1, fig. 1.

***Haplophragmoides horridus* (Grzybowski, 1901)**

Haplophragmium horridum Grzybowski, 1901, p. 270, pl. 7, fig. 12.
Haplophragmoides horridus (Grzybowski). – Kaminski & Gradstein, 2005, p. 347, pl. 77.

***"Haplophragmoides" stomatus* (Grzybowski, 1898)**
Plate 2, Fig. 2
Trochammina stomata Grzybowski, 1898, p. 290, pl. 11, figs 26, 27.
Haplophragmoides stomatus (Grzybowski). – Kaminski et al., 1993, pl., 11, fig. 1.

***Haplophragmoides suborbicularis* (Grzybowski, 1896)**

Cyclammina suborbicularis Grzybowski, 1896, p. 284, pl. 9, figs 5, 6.
Haplophragmoides suborbicularis (Grzybowski). – Jednorowska, 1968, p. 48, pl. 5, fig. 4.

***Haplophragmoides walteri* (Grzybowski, 1898)**
Trochammina walteri Grzybowski, 1898, p. 290, pl. 11, fig. 31.
Haplophragmoides walteri (Grzybowski). – Geroch, 1960, p. 49, pl. 5, fig. 5.

***Karrerulina* aff. *coniformis* (Grzybowski, 1898)**

Gaudryina coniformis Grzybowski, 1898, p. 259, pl. 12, fig. 7.
Plectina coniformis (Grzybowski). – Jednorowska, 1968, p. 60, pl. 8. figs 8-9.
Karrerulina coniformis (Grzybowski). – Kaminski *et al*., 1993, p. 269, pl. 13, figs 1-4.

***Karrerulina conversa* (Grzybowski, 1901)**
Plate 2, Fig. 13

Gaudryina conversa Grzybowski, 1901, p. 285. pl. 7, figs 15-16
Plectina conversa (Grzybowski). – Jednorowska, 1968, p. 60, pl. 8, figs 3-4.
Gerochammina conversa (Grzybowski). – Kaminski *et al*., 1993, p. 279, pl. 13, figs 5-11.
Karrerulina conversa (Grzybowski). – Kaminski & Gradstein, 2005, p. 468, pl. 116.

***Paratrochamminoides olszewskii* (Grzybowski, 1898)**
Plate 2, Figs 3-4

Trochammina olszewskii Grzybowski, 1898, p. 257, pl. 7, fig. 1.
Trochamminoides subcoronatus (Grzybowski, 1896). – Kaminski & Gradstein, 2005, p. 305, pl. 64.

***Placentammina placenta* (Grzybowski, 1898)**
Plate 1, Figs 13-14
Reophax placenta Grzybowski, 1898, p. 286, pl. 10, figs 9-10.
Saccammina placenta (Grzybowski). – Geroch, 1960, p. 37, pl. 2, figs 1-6.
Placentammina placenta (Grzybowski). – Kaminski & Gradstein, 2005, p. 136, pl. 11.

***Psammosiphonella cylindrica* (Glaessner, 1937)**

Rhabdammina cylindrica Glaessner, 1937, p. 354, pl. 1, fig. 1.
Psammosiphonella cylindrica (Glaessner). – Kaminski & Gradstein, 2005, p. 119, pl. 5/6.

***Psammosiphonella-Rhabdammina* group**
Plate 1, Figs 4-6

In this group are placed the tubular tests, with constant diameter, occurring in fragments, with a thick coarse-grained wall and smooth interior.

***Recurvoides* aff. *setosus* (Grzybowski, 1896)**
Plate 2, Fig. 7
Cyclammina setosa Grzybowski, 1986. p. 284, pl. 9, fig. 9.

***Recurvoides walteri* (Grzybowski, 1898)**
Plate 2, Fig. 9

Haplophragmium walteri Grzybowski, 1898, p. 280, pl. 10, fig. 24.
Recurvoides walteri (Grzybowski). – Olszewska *et al*., 1996, p. 72, pl. 24, figs 6-7.

***Rzehakina epigona* (Rzehak, 1895)**
Plate 1, Fig. 12

Silicina epigona Rzehak, 1895, p. 214, pl. 6, fig. 1.
Rzehakina epigona (Rzehak). – Geroch, 1960, p. 62, pl. 4, figs 14-16, pl. 10, fig. 1.

***Rzehakina lata* Cushman & Jarvis**
Rzehakina epigona (Rzehak) var. *lata* Cushman & Jarvis, 1928, p. 28, pl. 13, fig. 11.
Rzehakina lata Cushman & Jarvis. – Kaminski & Gradstein, 2005, p. 212, pl. 34.

***Rzehakina minima* Cushman & Renz, 1946**

Rzehakina minima Cushman & Renz, 1946, p. 24, pl. 3, fig. 5.

***Rzehakina fissistomata* (Grzybowski, 1898)**
Plate 1, Fig. 11
Spiroloculina fissistomata Grzybowski, 1898, p. 261, pl. 7, figs 22-24.
Rzehakina fissistomata (Grzybowski). – Geroch, 1960, p. 63, pl. 4, fig. 11.

***Spiroplectammina navarroana* Cushman, 1932**
Plate 2, Figs 14-17

Spiroplectammina navarroana Cushman, 1932, p. 96, pl. 11, fig. 14.

***Subreophax pseudoscalaris* (Samuel, 1977)**

Reophax pseudoscalaria Samuel, 1977, p. 36, pl. 3, fig 4.
Subreophax pseudoscalaris (Samuel). – Kaminski & Gradstein, 2005, p. 281, pl. 282.

***Subbotina* aff. *velascoensis* (Cushman, 1925)**

Globigerina velascoensis Cushman, 1925, p. 19, pl. 3, fig. 6.
Subbotina velascoensis (Cushman). – Olszewska *et al*., 1996, p. 133, pl. 42, figs 1-2.

***Thalmannammina subturbinata* (Grzybowski, 1898)**
Plate 2, Fig 8

Haplophragmium subturbinatum Grzybowski, 1898, p. 280, pl. 10, fig. 23.
Thalmannammina subturbinata (Grzybowski). – Kaminski *et al*., 1993, p. 253, pl. 4, fig. 5.

***Trochamminopsis* aff. *altiformis* (Cushman & Renz, 1946)**
Plate 2, Fig. 11

Trochammina altiformis Cushman & Renz, 1946, p. 258, pl. 2, fig. 20.
Trochamminopsis altiformis (Cushman & Renz). – Kaminski & Gradstein, 2005, p. 458, pl. 112.

***Trochammina* aff. *globigeriniformis* (Parker & Jones, 1865)**
Plate 2, Fig. 12

Lituola globigeriniformis Parker & Jones, 1865, p. 407, pl. 15, figs 46-47, pl. 17, figs 96-98.
Trochammina globigeriniformis (Parker & Jones). – Geroch, 1960, p. 65, pl. 7, fig. 2.

***Trochamminoides variolarius* (Grzybowski, 1898)**

Trochammina variolaria Grzybowski, 1898, p. 288, pl. 11, fig. 15.
Paratrochamminoides variolarius (Grzybowski). – Kaminski *et al*., 1993, p. 261, pl. 9, figs 5a-6c.
Trochamminoides variolarius (Grzybowski). – Olszewska *et al*., 1996, p. 69, pl. 22, fig. 21.

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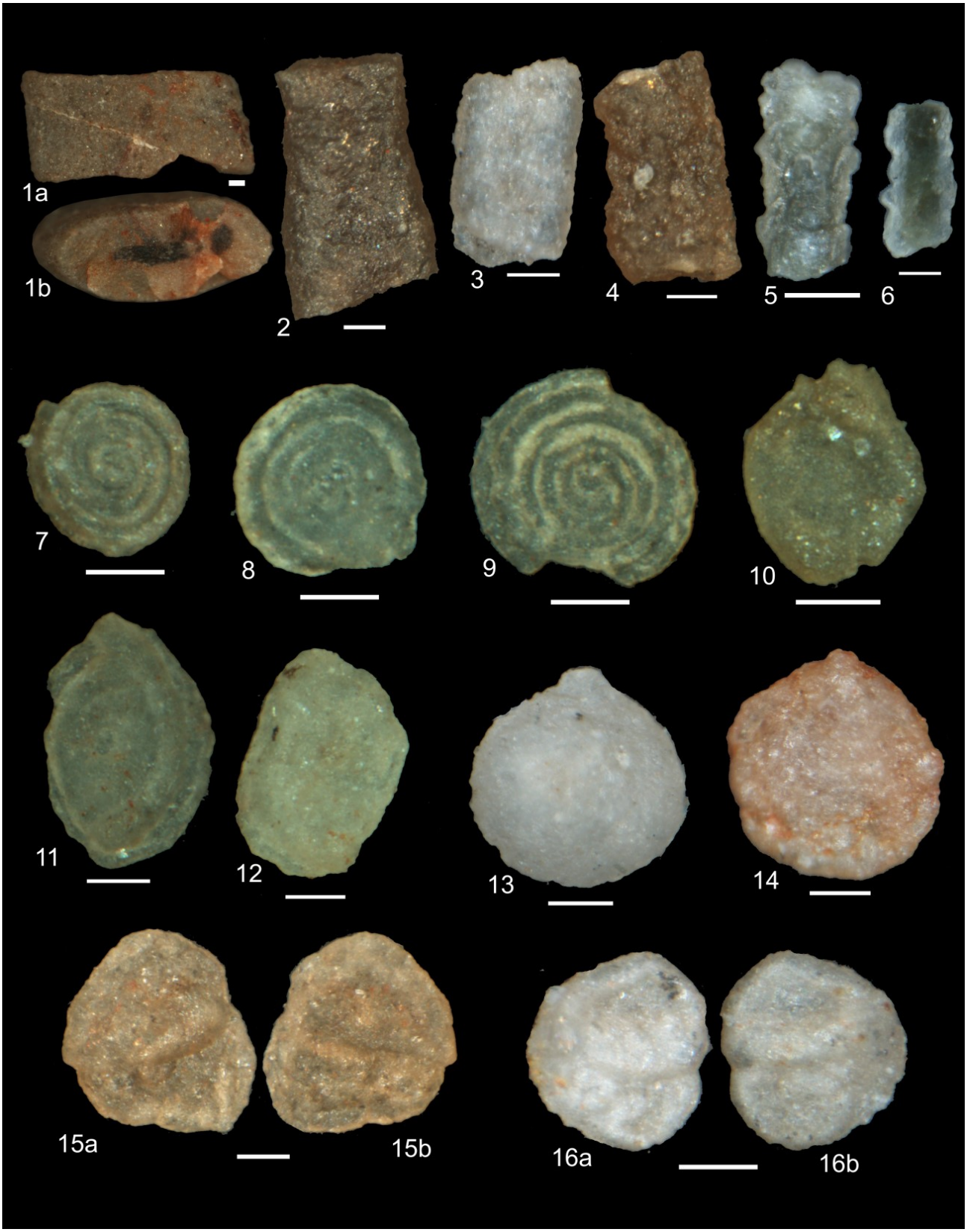

Plate 1. 1, 2. *Bathysiphon* sp., **3.** *Bathysiphon microrhapidus* Samuel**, 4, 5, 6.** *Psammosiphonella* sp.*,* **7, 8, 9.** *Annectina* sp. 1, **10.** *Caudammina* sp. *(Caudammina ovuloides?* (Grzybowski))*,* ***11.*** *Rzehakina fissistomata* (Grzybowski)*,* ***12.*** *Rzehakina epigona* (Rzehak)*,* ***13, 14.*** *Placentammina placenta* (Grzybowski)*,* ***15, 16.*** *Ammosphaeroidina pseudopauciloculata* (Mjatliuk*).* Scale bar is 100 µm.

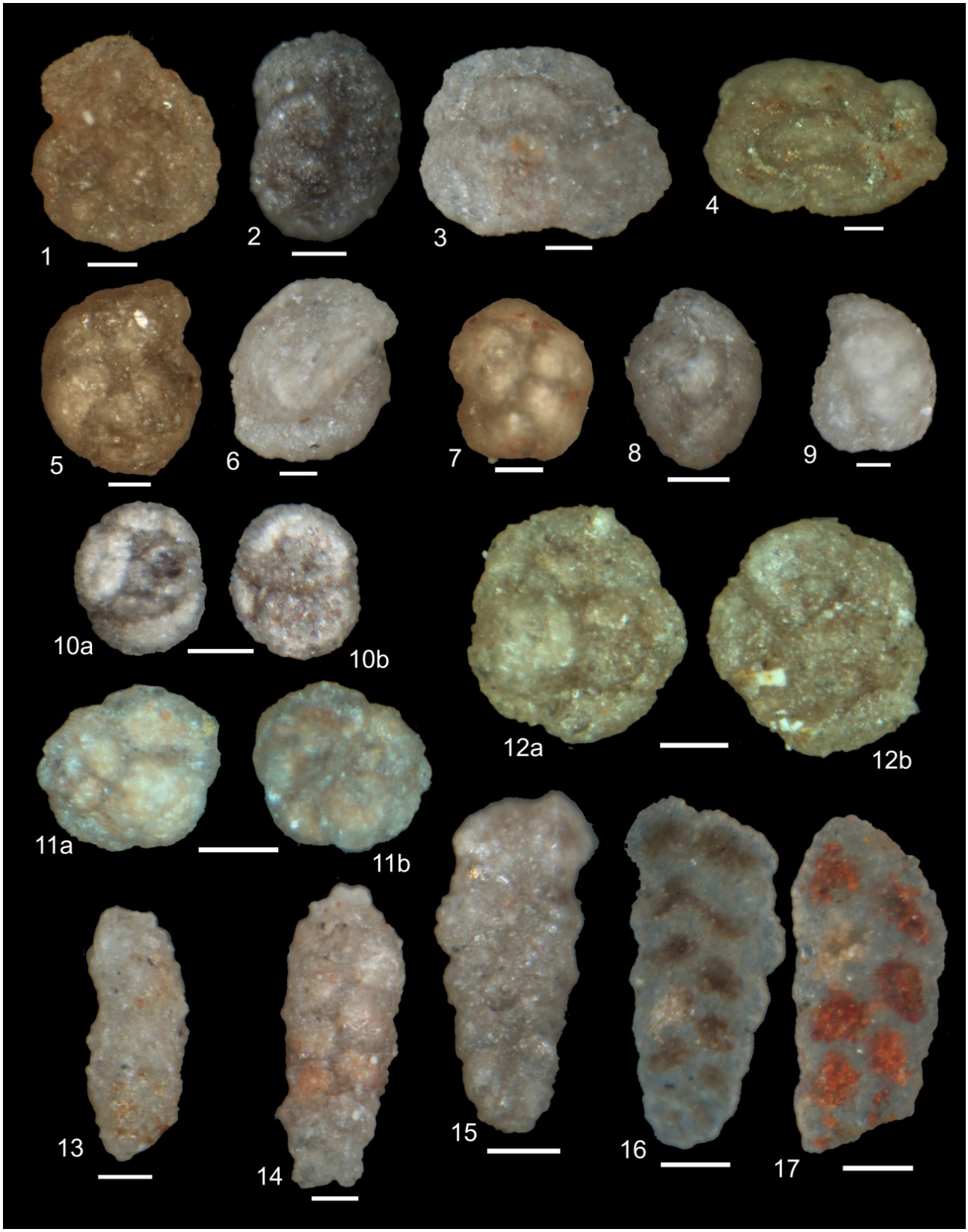

Plate 2. 1. *Haplophragmoides excavatus* Cushman & Waters, **2.** *Haplophragmoides stomatus* (Grzybowski), **3, 4.** *Paratrochamminoides olszewskii* (Grzybowski), **5, 6.** *Cribrostomoides subglobosus* (Cushman), **7.** *Recurvoides* aff. *setosus (Grzybowski),* **8.** *Thalmannammina subturbinata* (Grzybowski), ***9.*** *Recurvoides walteri* (Grzybowski), **10.** *Trochammina* sp., **11.** *Trochamminopsis* aff. *altiformis* (Cushman & Renz), **12.** *Trochammina* aff. *globigeriniformis* (Parker & Jones), **13.** *Karrerulina conversa* (Grzybowski), **14, 15, 16, 17.** *Spiroplectammina navarroana* Cushman. Scale bar is 100 µm.